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Results of Supplementing the Dietary of Substandard Workers with Cod Liver Oil and Milk

The Toxicology of the Carbonyls

Erysipeloid: Bacillus of Swine Erysipelas Infection—A Disease of Industry

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THE JOURNAL OF INDUSTRIAL HYGIENE

VOLUME XIV JUNE, 1932 NUMBER 6

RESULTS OF SUPPLEMENTING THE DIETARY OF SUBSTANDARD WORKERS WITH COD LIVER OIL AND MILK*

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IT is generally believed that underweight, and particularly undernourished, industrial workers are less efficient than those who are well-nourished. The lower efficiency is indicated by a greater number of absences and a smaller amount of work accomplished at routine tasks. This observation suggested the possibility of increasing the effectiveness of substandard workers by enhancing their usual dietary.

It was noted that many of the absences among this group of workers were caused by "colds." Since cod liver oil has long been prescribed for preventing colds, and since milk is particularly valuable for supplementing the dietary deficiencies of many food materials, these foods were considered as very desirable supplements to the usual home diets of underweight women dependent on industrial employment for a livelihood. Accordingly, it was arranged that a group of underweight women should be given supplementary feedings of one tablespoonful of cod liver oil and one pint of milk daily, separate from their ordinary home ration. The oil and milk were served during the morning and afternoon rest periods. The criteria used for judging the value of this supplementary feeding were increase in body weight, decrease in number of absences, and increase in efficiency at usual daily tasks. Data were also collected concerning the frequency and severity of colds and other illnesses, and concerning menstrual irregularities.

* Received for publication Feb. 29, 1932.

The duration of the experiment was from the middle of December to the middle of May. This is the season when the quality and quantity of sunlight is at a minimum, when the vitamin content of milk, vegetables, and other foods is somewhat decreased, and when colds and their sequelae are most prevalent.

In order that the results of this test should be directly comparable with those of a previous study (1), the milk and the cod liver oil were obtained from the same sources as in the earlier investigation. The milk was from the regular city delivery. It was produced and pasteurized by modern approved methods and met the usual standards for commercial milk. The cod liver oil was produced from fresh livers by the direct steam process at plants located along the Massachusetts shore. Its chemical and physical characteristics (2, pp. 263–264) were: specific gravity 0.923; refractive index 1.4788; saponification value 184.08; iodine number 168.73; free fatty acid 0.63 per cent.; and unsaponifiable material 1.31 per cent. Its vitamin A content (2, p. 469) was in excess of 1,250 vitamin A units per gram.

Sixty-three young women served as subjects—forty-five in a one-year test and eighteen in a test of two years' duration. The women participating in both tests were industrially employed at tasks rated as light muscular activity. Their ages ranged from 18 to 45 years: Eleven were under 21 years, thirty-six were between 20 and 30, and sixteen were over 30. At the time of the initial weighing, the women were all underweight, the range being from 1.4 per cent. to 29.4 per cent.; over 50 per cent. were more than 10 per cent. underweight.

One-Year Test

The forty-five women participating in the one-year test were from 1.4 per cent. to 22.6 per cent. underweight at the beginning of the test. They were employed at tasks similar to those of the twenty-six women included in the previous study, but none of them participated in the earlier study. The data which were collected during the experimental period (December to May) relative to changes in body weight, absences from work, and efficiency at specified tasks will be discussed separately.

Body Weight.—The subjects were weighed each week, Wednesday being chosen since it was the day likely to be least influenced by week-end activities. The weekly weights for the different individuals have been reduced to an average per person basis for each week of the experimental period, and are reported in Figure 1.

It will be noted from this chart that the average ideal weight for the subjects was 127 pounds. At the beginning of the experiment, however, they averaged only 112.4 pounds, or 14.6 pounds below the ideal weight. They gained fairly consistently for the first twelve weeks, but after that their weight remained practically stationary. The average gain was 2.6 pounds. For the information of those interested in individual variations, data are presented in Table 1 concerning the age, ideal weight, initial weight, percentage underweight at the beginning of the test, final weight, percentage underweight at the end of

the test, and percentage increase or decrease in weight for each subject.

Absences Due to Illness.—A daily attendance record was kept for each subject. At the time this was taken, those who had been absent were asked concerning the cause of the absence, and these data were incorporated in the records. For the purpose of this report, however, the total individual absences for each month have been reduced to an average basis, and are presented in graphic form in Figure 2. In order to provide a basis for judging the effect of the supplementary feeding on the amount of time lost from work, a "pre-experiment" curve, reporting the hours of absence per person due to illness for the same individuals during the year preceding the test period, has been included.

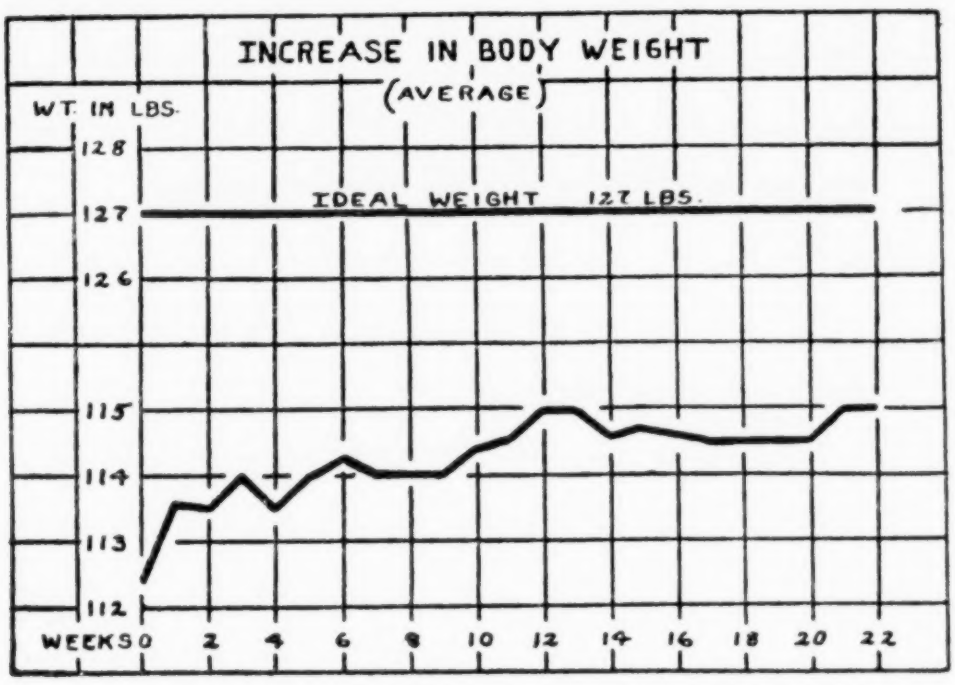

FIG. 1.—Average weekly weights for subjects of one-year test.

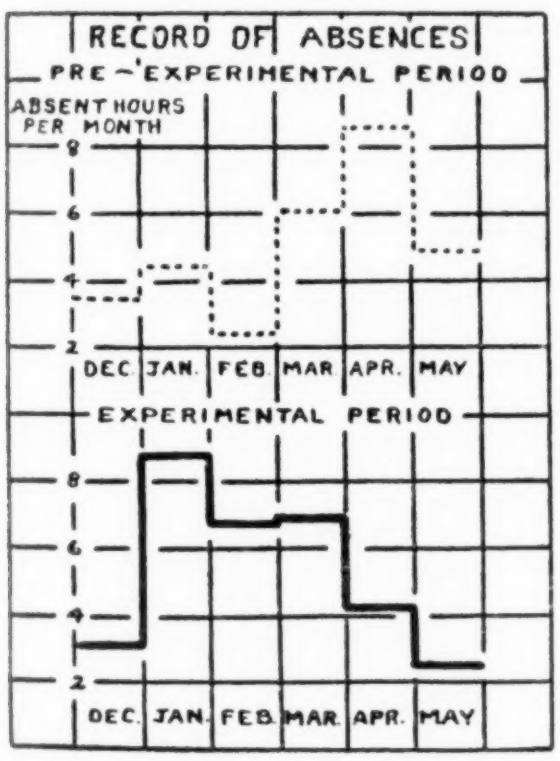

FIG. 2.—Average hours of absence per person per month for subjects of one-year test.

During the year previous to the administration of cod liver oil and milk, the number of hours of absence per person per month increased more or less consistently from December to April—the average person was absent the equivalent of one day during the month of April. On the other hand, during the experimental period the greatest number of hours of absence per person occurred during the month of January. Beginning with January, the remainder of the experimental period showed a consistently decreasing number of hours of absence per person per month, with a minimum of two and one-half hours for the month of May.

TABLE 1.—INCREASE IN BODY WEIGHT DURING ONE-YEAR EXPERIMENTAL PERIOD

AGE OF SUBJECT	IDEAL WEIGHT	INITIAL WEIGHT	UNDER-WEIGHT	FINAL WEIGHT	UNDER-WEIGHT	INCREASE OR DECREASE
yrs.	*lbs.*	*lbs.*	*%*	*lbs.*	*%*	*%*
20	126	114½	9.1	114½	9.1	0.0
20	116	110¾	4.5	109¾	5.3	−0.8
18	123	110½	10.1	114¾	6.7	3.4
20	133	123	7.5	125¼	5.8	1.7
18	128	121	5.4	120	6.2	−0.8
20	118	101	14.4	101¾	13.7	0.7
20	119	108½	8.8	110¼	7.3	1.5
18	123	121¼	1.4	121¾	1.0	0.4
20	114	101½	10.9	105	7.8	3.1
18	125	109¼	12.6	116	7.2	5.4
21	130	123	5.3	130½	0.3[1]	5.6
21	132	121	8.3	116¾	11.5	−3.2
25	128	104½	18.3	107½	16.0	2.3
21	139	123¼	11.3	120	13.6	−2.3
23	123	112	8.9	110¾	9.9	−1.0
21	118	104	11.8	106¾	9.5	2.3
26	123	116	5.6	115	6.5	−0.9
23	124	101	18.5	107½	13.3	5.2
22	123	113¼	7.9	121	1.6	6.3
25	120	106	11.6	105¼	12.2	−0.6
23	136	114½	15.8	110	19.1	−3.3
24	127	112½	11.4	113¼	10.8	0.6
27	123	116¾	5.0	122	0.8	4.2
22	118	103	12.7	103¾	12.0	0.7
26	130	100½	22.6	104½	19.6	3.0
21	128	111½	12.8	109¼	14.6	−1.8
21	132	104¼	21.0	102	22.7	−1.7
26	139	121¼	12.7	122¾	11.6	1.1
28	127	101¼	20.2	105½	16.9	3.3
25	121	118	2.4	121½	0.4[1]	2.8
27	128	112½	12.1	110¾	13.4	−1.3
21	131	102¼	21.9	106¾	18.5	3.4
24	123	102¾	16.4	99¼	19.3	−2.9
37	133	109	18.0	112	15.7	2.3
30	132	108½	17.8	113	14.3	3.5
37	127	104½	17.7	111¾	12.0	5.7
36	134	128½	4.1	131¼	2.0	2.1
40	128	115	10.1	114¼	10.7	−0.6
32	133	119	10.5	117½	11.6	−1.1
40	125	113½	9.2	116	7.2	2.0
36	135	115½	14.4	115¾	14.2	0.2
30	135	125¾	6.8	126¼	6.4	0.4
35	142	134	5.6	133¼	6.1	−0.5
45	138	131	5.0	136	1.4	3.6
36	124	113	8.8	117½	5.2	3.6

Total gain in weight for average person = 2.6 lbs.
Total to gain = 14.6 lbs.

[1] Overweight.

Efficiency Rating.—In order to ascertain the efficiency of the group receiving supplementary feedings, a record was made of the efficiency of each individual for each week of the experimental period. These weekly records have been averaged and reduced to a monthly basis (see Fig. 3). For the sake of comparison, data have also been included concerning the efficiency of the same individuals for the corresponding period of the previous year (pre-experimental period). It is interesting to note that the February

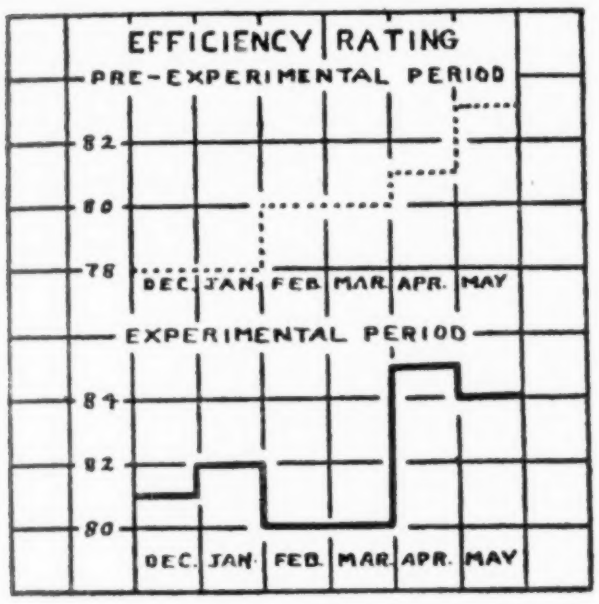

FIG. 3.—Efficiency rating for subjects of one-year test.

and March ratings were the same for both years, and that the efficiency for the experimental period was greater than during the year previous to the use of cod liver oil and milk as dietary supplements.

Menstrual Irregularities.—In the previous paper (1) attention was called to the observations of Wolbach and Howe (3), Macy and her collaborators (4), Read and Palmer (5), Sure (6), Hughes, Aubel, and Leinhardt (7), Holmes, Doolittle, and Moore (8), Poulsson (9), McClendon, Burr, and Wildebush (10), and Macomber (11), concerning a possible relationship between vitamin A deficiency and disturbed reproductive functions. It was noted in the earlier study that coincident with the enhancing of the vitamin A content of the usual home diet by the supplementary use of cod liver oil and milk, the menstrual irregularities of some of the subjects improved. Accordingly, attention was given to this condition in the present test.

Fourteen of the women who served as subjects (twelve participating in the one-year test and two from the two-year test reported below) stated at the beginning of the test that they were troubled with various menstrual irregularities: seven with irregular menstrual periods, five with dysmenorrhea, and two with severe menstrual headaches. At the conclusion of the test, four of the seven troubled with irregular periods were normal, two were definitely improved, and the seventh showed little improvement. One of the women troubled with dysmenorrhea was entirely free of this difficulty at the end of the test, three were much improved, and one could see no change. One of those having menstrual headaches was no longer troubled, and the other reported gradual improvement. These women were absent 195 less hours during the experimental period than during the corresponding time the year previous, and they showed an average gain in weight of 2.3 pounds. It is perhaps more than a coincidence that the enhancing of the vitamin A content of the usual home diets of these women troubled with menstrual irregularities was followed by definite improvement of the condition.

Two-Year Test

Eighteen women participated two successive years in a test of the economic value of cod liver oil and milk as dietary supplements. They were from 7.9 per cent. to 29.4 per cent. underweight at the beginning of the experiment, and their ages varied from 19 to 40 years. The experimental periods were from the middle of December to the middle of May.

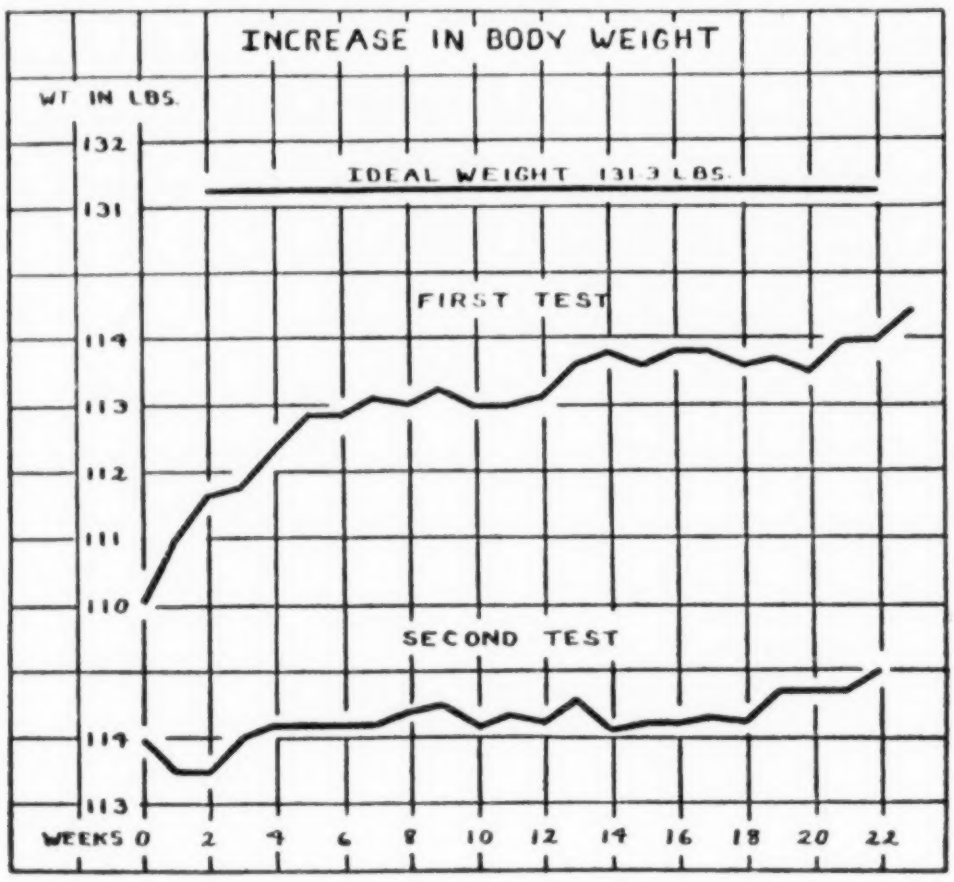

FIG. 4.—Average weekly weights for subjects of two-year test.

Body Weight.—The weekly weights for the different members of the group have been reduced to an average per person basis. Figure 4 shows the ideal weight, and the average weekly weights for the first and second year tests with the eighteen women under observation.

The ideal weight for the group was computed to be 131.3 pounds. At the beginning of the first test the subjects averaged over 20 pounds underweight. During the first five weeks of the first test there was a gain of nearly 3 pounds per person. After the fifth week, however, the gain, although continuous, was not so rapid as during the first part of the test. The total gain for the test was 4.5 pounds per person.

At the beginning of the second test, about seven months after the completion of the first, the average weight per person was 114 pounds. The gain during this test was less than during the first, being slightly over 1 pound per person.

While the average weights give a general idea of the reaction of the group as a whole to the use of cod liver oil and milk as supplements to the usual home diet, the change in weight of the different members of the group may also be of interest. Accordingly, data concerning the ideal weight, initial weight, initial percentage underweight, final weight, percentage underweight at final weighing, percentage increase or decrease for two test

periods, and the number of pounds gained or lost during the two tests are reported in Table 2.

Three in the group lost weight—a total of $7\frac{3}{4}$ pounds, or an average of 2.6 pounds. The other fifteen gained $64\frac{1}{4}$ pounds, or an average of 4.3 pounds.

Absences Due to Illness.—The average hours of absence per month per person for three years—for the two years of the test and for the year preceding—have been plotted as curves, which are shown in Figure 5. It will be noted that the absences due to illness decreased very materially from year to year. The group of eighteen women were absent from work $663\frac{1}{2}$ hours less during the first test than during the corresponding period in the year previous to the test. In the second test they were absent 498 hours less than during the first test. On reducing these absences to an average basis it will be found that the average number of hours of absence per person per year was 105.3 for the pre-experimental period, 68.4 for the first test, and 40.8 for the second test—a total reduction of 61 per cent. It requires no imagination for the reader to appreciate the economic importance of such a reduction in lost time to those dependent upon their wages for their livelihood.

TABLE 2.—INCREASE IN BODY WEIGHT DURING TWO-YEAR EXPERIMENTAL PERIOD

IDEAL WEIGHT	INITIAL WEIGHT	UNDER-WEIGHT	FINAL WEIGHT	UNDER-WEIGHT	INCREASE OR DECREASE	AMOUNT GAINED OR LOST IN 2 YRS.
lbs.	*lbs.*	*%*	*lbs.*	*%*	*%*	*lbs.*
123	113	8.1	114	7.3	0.8	1
120	$109\frac{1}{4}$	8.9	112	6.6	2.3	$2\frac{3}{4}$
139	128	7.9	$129\frac{1}{2}$	6.8	1.1	$1\frac{1}{2}$
134	108	19.4	110	17.9	1.5	2
140	$115\frac{3}{4}$	17.3	$132\frac{1}{4}$	5.5	11.8	$16\frac{1}{2}$
124	$108\frac{3}{4}$	12.2	$113\frac{3}{4}$	8.2	4.0	5
125	$104\frac{3}{4}$	16.2	112	10.4	5.8	$7\frac{1}{4}$
127	113	11.0	118	7.0	4.0	5
128	110	14.0	114	10.9	3.1	4
126	$104\frac{1}{4}$	17.2	$110\frac{1}{2}$	12.3	4.9	$6\frac{1}{4}$
124	$101\frac{3}{4}$	17.9	$102\frac{1}{2}$	17.3	0.6	$0\frac{3}{4}$
148	135	8.7	137	7.4	1.3	2
141	$126\frac{1}{4}$	10.4	$123\frac{1}{2}$	12.4	−2.0	$-2\frac{3}{4}$
135	117	13.3	119	11.8	1.5	2
133	119	10.5	$115\frac{3}{4}$	12.9	−2.4	$-3\frac{1}{4}$
130	$91\frac{3}{4}$	29.4	94	27.6	1.8	$2\frac{1}{4}$
120	91	24.1	97	19.1	5.0	6
131	$112\frac{1}{2}$	14.1	$110\frac{3}{4}$	15.4	−1.3	$-1\frac{3}{4}$

Efficiency Rating.—The weekly efficiency ratings for the members of the group for the two years of the test and the year previous have been assembled and reduced to an average monthly basis. These average values have been plotted as curves in Figure 6.

During the pre-experimental period, with the exception of December, the efficiency of the group remained between 76 and 78, with an average of

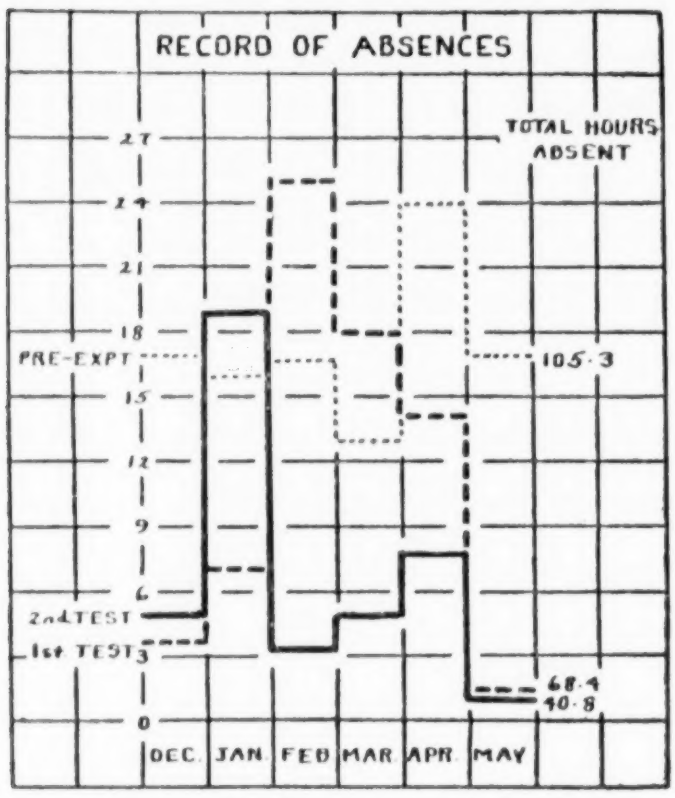

FIG. 5.—Average hours of absence per person per month for subjects of two-year test.

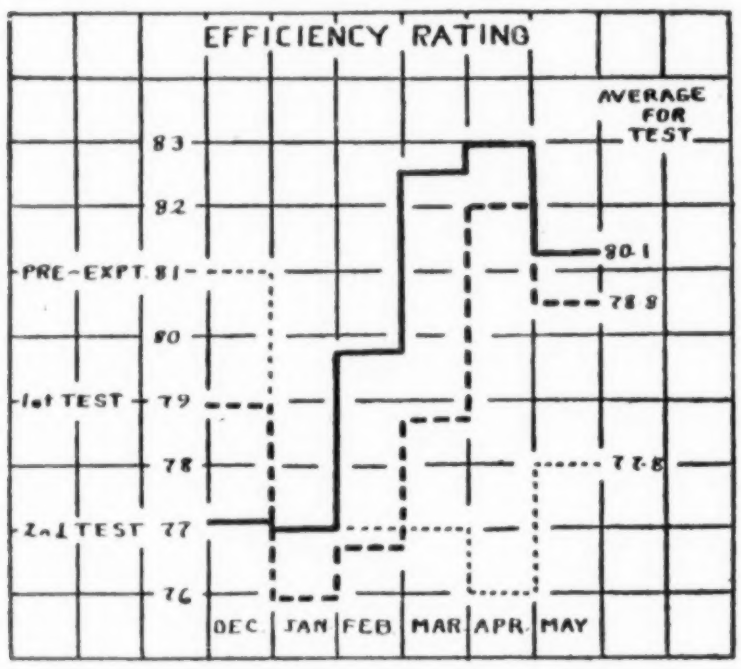

FIG. 6.—Efficiency rating for subjects of two-year test.

77.8. The efficiency for the first test was noticeably improved, being 78.8 for the average person for the period of the test, and during the second test it was still higher—80.1.

SUMMARY AND CONCLUSION

Sixty-three underweight young women served as subjects of an investigation conducted to determine whether cod liver oil and milk taken as supplements to the usual home diet of substandard women would improve their health and efficiency. All the women were employed at tasks classified as light muscular activity. Cod liver oil of known history and high grade commercial milk were ingested in the forenoon and afternoon rest periods.

A daily record was made of attendance and the cause of previous absences and illnesses. Weekly records were made of body weight and efficiency rating. The addition of cod liver oil and milk to the usual home diets of the forty-five young women included in the one-year test was followed in the majority of instances by an increase in body weight—an average of 2.6 pounds—by a decrease in absences from employment, and by an increase in efficiency.

At the time of the initial weighing, fourteen of the women stated that they suffered from menstrual irregularities—seven from irregular menstrual periods, five from dysmenorrhea, and two from severe menstrual headaches. Of these, six reported that their menstrual irregularities were completely corrected, six were benefited, and two could see little if any improvement from the use of cod liver oil and milk. These women were absent from employment 195 hours less than during the corresponding time the year previous.

In the two-year test, all but three of the eighteen women gained in weight each year—an average of 4.5 pounds

during the first year and an average of 1 pound during the second year.

The absence record for the members of this group showed a very definite improvement following the addition of cod liver oil and milk as supplements to the usual home diet. The average hours of absence (December to May) totaled 105.3 for the year previous to the test, 68.4 for the first year, and 40.8 for the second year—a total reduction of 61 per cent.

The average efficiency for the group was 77.8 for the year previous to the test, 78.8 for the first year, and 80.1 for the second year.

Since the use of cod liver oil and milk as supplements to the usual home diets of substandard young women was followed by an increase in body weight, a decrease in absences from employment, an increase in efficiency rating, and an improvement in the menstrual irregularities experienced by some of the women, it is apparent that the addition of cod liver oil and milk to the usual home diet contributes very materially to the well-being and efficiency of underweight young women dependent upon their ability to work for a livelihood.

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THE TOXICOLOGY OF THE CARBONYLS*

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THE carbonyls (1), compounds of carbon monoxide and the metals, were discovered and named by Mond, Langer, and Quincke in the year 1890. The first of this interesting series of organometallic compounds, nickel carbonyl, was prepared by passing carbon monoxide over freshly reduced, finely divided nickel. The reaction of formation of nickel tetracarbonyl ($Ni(CO)_4$) is a reversible one, the gas dissociating into carbon monoxide and nickel at temperatures over 180°C., and this reaction forms the basis of the Mond process for the refining of pure nickel. Nickel carbonyl is a heavy, colorless liquid with a specific gravity of 1.38 and a boiling point of 44°C. It is readily attacked by oxidizing agents such as nitric acid, chlorine, and bromine, with the liberation of carbon monoxide and the formation of the corresponding salt of the metal.

Of the carbonyls of iron, cobalt, molybdenum, etc., the only one of commercial importance is that of iron. Iron pentacarbonyl is more difficult to prepare than nickel carbonyl and is slightly less toxic. It is an amber-colored liquid with a specific gravity of 1.4 and a boiling point of 102°C. On exposure to air the liquid burns with a bright flame, and on exposure to light, decomposes with the liberation of carbon monoxide and the formation of a lower carbonyl.

But little is known of the toxic properties of the carbonyls of the rarer metals, and the following description applies in particular to nickel carbonyl and the slightly less toxic carbonyl of iron.

TOXICITY

The liquid carbonyls are highly toxic substances both when injected into the body in the form of liquid and when inhaled as a gas. Investigation into the effects produced by inhalation is rendered difficult by the readiness with which dissociation into the metal and carbon monoxide takes place under varying conditions of temperature, reaction, and humidity; and under conditions of the industrial manufacture of nickel carbonyl, a considerable quantity of carbon monoxide is always present.

McKendrick and Snodgrass (2) investigated experimentally the action of carbonyl and assumed that a concentration of 0.5 per cent. was very dangerous. This figure is certainly too high. Haldane (3) states that 0.05 per cent. of carbon monoxide in the atmosphere will produce distinct symptoms which are appreciable during rest, and that 0.2 per cent. will produce urgent symptoms. It can be shown that nickel carbonyl is relatively at least five times as toxic as

* Received for publication Feb. 13, 1932.

carbon monoxide. Armit (4), investigating the dosage on rabbits, found that a concentration of 0.018 volume per cent. would kill a full-grown healthy rabbit after one hour's exposure.

The determination of the quantity present in the atmosphere is made by aspirating a known volume of filtered air through aqua regia, and subsequently determining the quantity of nickel salts present in solution.

Pathology

Armit (4), after much experimental work, assumed that on inhalation, nickel carbonyl dissociated in the lung with the deposition of a basic nickel hydrate or carbonate, and that the immediate symptoms were due to the formation of carboxyhemoglobin by the liberated carbon monoxide. It is doubtful, however, whether this happens to any marked extent, as experimentally, nickel is not found in the lung nor is any present in the sputum of those clinical cases which have come under observation. It would appear that most, if not all, of the inhaled vapor passes through the pulmonary epithelium into the blood stream unchanged and that the pulmonary epithelium is severely and directly damaged by the passage through it of the unchanged carbonyl. Support is lent to this theory by a private communication from Professor Haldane in 1903, who stated that he was unable to find carboxyhemoglobin in the blood of mice which had been poisoned with nickel carbonyl. Further, the changes in the central nervous system are of a much severer nature than those associated with carbon monoxide poisoning, and evidence of the presence of nickel in the liver and the urine warrants the assumption that the carbonyl has entered the blood stream unchanged.

Morbid Anatomy

Lungs.—Microscopically, the lungs are in a state of acute vascular congestion, with marked capillary engorgement. The mucous membrane of the bronchial tubes is swollen and hyperemic. Experimentally, this vascular congestion is so marked that almost complete obliteration of the air sacs may occur. Later it may be demonstrated that degenerative changes have taken place in the pulmonary epithelium, with desquamation of the cells into the alveoli. Hemorrhage or exudation into the alveoli is uncommon, and consolidation, either of lobar or lobular distribution, is not found. About the third day there occurs some marked round-celled peribronchial infiltration usually affecting the larger tubes.

Cardiovascular System.—No specific changes occur in the heart or blood vessels. Contrary to the findings in poisoning by certain other metals, there is no characteristic blood picture. The leukocytosis described by MacCallum (5) has not been observed. The blood counts in a series of cases investigated in 1929 are shown in Table 1.

Central Nervous System.—The effects of nickel carbonyl on the nervous system were observed by the late Sir Frederick Mott (6) in 1903, in an examination of the brains of two fatal cases. He described the piarachnoid as possessing a rusty appearance. Throughout the hemispheres were fine capillary hemorrhages, which were

especially noticeable in the corpus callosum and the subcortical white matter. Microscopically, chromatolytic changes were found in the cells of the cerebral cortex and in the cardiorespiratory centers of the medulla. The symmetrical areas of softening, described as common in carbon monoxide poisoning by MacCallum (5), were not found.

TABLE 1.—DIFFERENTIAL BLOOD COUNTS IN SIX CASES OF NICKEL CARBONYL POISONING

CASE	POLYMORPHONUCLEARS	EOSINOPHILS	BASOPHILS	LYMPHOCYTES		LARGE MONONUCLEARS
				Small	Large	
	%	%	%	%	%	%
1	57	5	0	34	4	0
2	57	7	0	29	7	0
3	64	1	0	31	3	1
4	71	4	0	20	3	2
5	67	3	0	24	4	2
6	72	4	0	20	3	1

Gastro-Intestinal and Urinary Systems.—No characteristic changes have been described in the gastro-intestinal or urinary systems, but the occurrence of slight albuminuria and the excretion of minute quantities of nickel in the urine are of great interest. Experimentally, the liver is always found to contain nickel after poisoning by nickel carbonyl, but the bile in those cases on which postmortems have been performed, has been found to contain none.

Symptoms

The symptoms of nickel carbonyl poisoning fall into two groups—the immediate and the remote. Between these there is a latent period, a characteristic common to other forms of gas poisoning. This period varies between twelve and eighteen hours, during which recovery from the immediate symptoms may appear to be so complete as to allow the workman to return to work.

Immediate Symptoms.—Soon after the inhalation of the gas, complaint is made of a feeling of giddiness, headache, and nausea. Occasionally vomiting occurs. The gait becomes unsteady, and in industrial practice where the carbonyl is always mixed with a larger quantity of carbon monoxide, if much of this latter is inhaled there may be complete unconsciousness, the clinical picture resembling that of carbon monoxide poisoning. In those who have been exposed to a low concentration over a long period of time, there may be complaint only of a throbbing frontal headache. After adequate treatment these symptoms may clear up completely, to be followed by the remote symptoms.

Remote Symptoms.—The onset of the second stage is heralded by the development of retrosternal soreness and the inability to take a deep breath without pain. This soreness is nearly always limited to that part of the sternum opposite the second, third, and fourth costal cartilages. A dry, ineffective cough develops and only a little frothy or tenacious mucus is coughed up. The most characteristic symptom is dyspnea. This increases with and is out of all proportion to the amount of exertion. Cyanosis of the lips and ears develops and is a sign of ill omen. Its depth is a direct indication of the seriousness of the case. The skin is pale, the forehead is cold and clammy, and the facies is one of

great anxiety. The pulse rate increases in frequency and at first the pulse volume is increased. Later, with increasing frequency, the pulse becomes thready in character. In the early days of the illness the temperature is normal, but in the severest cases it rises as the illness progresses.

General Symptomatology

The physical signs in the chest increase until about the sixth day, when in all but the severest cases, the retrosternal soreness and the dyspnea begin to disappear. In the severer cases, the pulse-respiration ratio increases until it may reach as high as 2:1, with a marked increase in the cyanosis. The heart shows evidence of marked dilatation.

In the early stages there is a marked bilateral diminution of movement of the chest. This is confirmed by palpation, and at the end of the first day there is a general increase of vocal fremitus. The percussion note is not markedly altered but there is a sense of increased resistance. In the severest cases there is some bilateral dulness at the bases. The altered quality of the breath sounds is of great significance, and in the early stages is heard best in the interscapular region. The change consists in a marked prolongation of the inspiratory note with a tendency to the development of bronchial breathing, except that expiration and inspiration tend to resemble one another in length. Depending on the severity of the case, this type of breath sounds may be heard over the whole lung. Fine, dry crackling crepitations accompanying both phases of respiration are generally distributed by about the third day.

Early accentuation of the pulmonary second sound is a common and early sign. As the disease progresses, the signs of cardiac dilatation develop, with an increase in the area of the impulse at the apex and an increase in the area of cardiac dulness, especially to the right of the sternum. There is an early increase in the deep reflexes. Sleeplessness is common and there is some dilatation of the pupils although they remain active to light. There is never any marked clinical evidence of organic damage to the nervous system.

Anorexia and epigastric pain and tenderness are common complaints. The epigastric pain usually develops on the second day, but vomiting is uncommon after the initial symptoms are over.

Pain in the loins is a fairly common complaint and there is invariably a trace of nickel in the urine collected during the first forty-eight hours. Occasionally, slight jaundice develops on the second or third day, and marked constipation nearly always occurs.

Diagnosis

The history of exposure is of tantamount importance in diagnosis, and the occurrence of the immediate symptoms would naturally lead at once to an examination of the place where the workman was at the time. The collection of the urine passed in the first forty-eight hours is also of great importance. It is obviously impossible to determine immediately whether poisoning is due to carbonyl or to carbon monoxide, as the two gases always occur together in an industrial plant. In laboratory practice, where pure carbonyl may be used, this difficulty does not arise, but pneumonia, bronchitis, and other pulmonary conditions must be taken into consideration.

In all suspected cases of carbonyl poisoning, it is the practice to withdraw 5 c.c. of blood from a vein and examine it for the presence of nickel and carbon monoxide. Carbon monoxide hemoglobin should be tested for spectroscopically and by the dilution method of Haldane. The sample for spectroscopic examination should be diluted 1 in 20 and divided into two parts, one of which should be reduced with Stokes' reagent. Both samples should then be examined in a spectroscope which is fitted with a comparison prism. The tannic acid and alkali tests for carboxyhemoglobin have not been found satisfactory in practice.

Treatment

It cannot be too strongly emphasized that correct treatment of the immediate symptoms and the exercise of great care during the subsequent twenty-four hours are of the greatest importance. In all cases where the diagnosis is doubtful, absolute rest must be insisted upon so that the minimum strain is put upon the heart and lungs.

When the degree of asphyxia is severe, the immediate treatment should be that of carbon monoxide poisoning. If there are signs of respiratory failure, a hypodermic injection of *a*-lobeline (Ingelheim) 3/20 grain is recommended and a mixture of oxygen 95 per cent. and carbon dioxide 5 per cent. should be administered. In severe cases it may be necessary to resort to artificial respiration. It is of the greatest importance to keep the patient warm, and the common practice of removing gas-asphyxiated patients into fresh air, regardless of the surrounding temperature, should be strongly deprecated. If there is evidence of cardiac failure, an injection of cardiazol 1 c.c. or digitalin 0.01 grain should be given. During the succeeding forty-eight hours, absolute rest should be insisted upon.

The patient should be nursed in a light, well-ventilated room, and the general rules applicable to a case of pneumonia should be followed. The diet should be light and easily digested, and should consist mainly in milk, eggs, and meat extracts. The bowels should be opened with a dose of calomel to be followed in the morning by a saline aperient. Restlessness and insomnia are best treated by the administration of bromides.

The treatment of the cyanosis requires special consideration. It may be necessary to give continuous oxygen inhalations, or, if the cyanosis is not of marked degree, to administer high concentrations by means of a Leonard Hill mask. It is better to administer the oxygen after it has been warmed.

Bleeding has not been found of great value but the injection of atropine sulphate 0.01 grain, repeated at hourly intervals, has been very useful in some cases.

During the period of convalescence, the administration of iron and quinine is useful; the amount of exertion in the early days of convalescence must be limited, and the degree of dyspnea must be the main indication in governing the return to work and the type of work performed until there is complete recovery.

Prognosis

The immediate prognosis depends on the degree of pulmonary involve-

ment and the degree of dyspnea. Cyanosis, pulse-respiration ratio, and cardiac dilatation are of the greatest importance. The remote prognosis in all cases which have recovered is good, and there is no case on record in which return to work has not followed poisoning by this gas.

Safety Measures

Liquid nickel carbonyl presents considerable difficulty in handling and should be stored in strong glass or steel containers, preferably under an inert gas such as carbon dioxide or nitrogen. Use in laboratories merits the most scrupulous care, and all measurements and reactions should be carried out in well-ventilated fume cupboards.

Nickel carbonyl burns with a bright yellow luminous flame and its property of importing a yellow color to the blue flame of burning alcohol is made use of in testing for small leaks in the manufacturing plant. The presence of 1 part in 80,000 is sufficient to import this luminosity.

The manufacture of nickel carbonyl entails certain definite hazards, and continual testing for leaks is the most important precautionary measure. In the eventuality of a breakdown of the plant, or the sudden occurrence of large leaks, the men engaged on repair work should wear respirators which are connected with a supply of pure compressed air. For this purpose, compressed air should be available in all parts of the manufacturing plant, for it has been found that this type of respirator gives perfect safety.

The finely divided, reduced nickel in industrial plants is capable of holding in an adsorbed state a considerable quantity of carbonyl. Before allowing men to work in the vicinity of this matte, the plant should be tested for the presence of carbon monoxide, and for this purpose a portable carbon monoxide detector may be usefully employed. In this, the color change produced in activated iodine pentoxide indicates the presence of carbon monoxide, and within certain limits, gives a fairly accurate estimation of the quantity present. A sample of the matte should also be examined for the presence of adsorbed carbonyl, by drawing a current of air through it and then passing the air through aqua regia. This should then be taken to dryness and the residue examined for the presence of nickel salts. If the matte should contain any adsorbed carbonyl, it should be fired or raised to the temperature at which carbonyl dissociates.

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ERYSIPELOID: BACILLUS OF SWINE ERYSIPELAS INFECTION—A DISEASE OF INDUSTRY*

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INFECTION of industrial workers with the bacillus of swine erysipelas has received little attention as a disease of industry and is apparently insufficiently known to physicians engaged in industrial medicine. Such an infection, called erysipeloid of Rosenbach, is well known to dermatologists and is more fully described in textbooks on dermatology than elsewhere. Patients with this infection, however, are less likely to be seen by dermatologists than by surgeons, since the clinical picture resembles a commonplace infection of the finger.

The infection occurs at the site of injury in workers in various industries involving contact with living and dead matter of animal and plant origin. It is therefore of importance to the industrial physician as well as in relation to workmen's compensation laws.

ORGANISM OF SWINE ERYSIPELAS

Dissemination, Strains, Virulence, and Resistance

The wide dissemination of the bacillus of swine erysipelas is extraordinary. Its habitat is dead matter of animal and plant origin. Swine are more frequently infected than other animals, and according to German investigators, a large percentage of all swine are carriers of the organism without showing symptoms of the infection. The organism has been demonstrated in diseased cattle, sheep, and birds.

The bacillus of swine erysipelas is apparently either pathogenic or saprophytic throughout the animal kingdom; its virulence varies considerably in different species. It is highly pathogenic to white mice and pigeons, and nonpathogenic to guinea-pigs and rabbits (except in the latter when a heavy suspension is injected intravenously). It is also nonpathogenic to field mice (a means of differentiation). Man is relatively immune, particularly through the gastro-intestinal route. In human and swine infection the organism has an affinity for the skin.

There are three generally accepted strains of the bacillus—human, swine, and mouse (Bacillus murisepticus)—which have been modified in virulence and somewhat in morphology through prolonged passage in their respective hosts. It is known that the virulence of the swine strain of the organism can be modified by passage through animals and also by culture. For example, passage through rabbits renders it much less virulent to swine, and

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passage through pigeons increases its virulence for all animals. Prolonged passage in dead animal matter apparently modifies its virulence and may account for differences in morphology.

The manifold adaptability of the bacillus may well explain its pathogenicity for different species of animals; at least in the swine there exists a transition from saprophyte to parasite, and a reversal from parasitism to saprophytism.

The organism appears as coccoid and also as straight or slightly curved rods, from 1 to 1.5 microns in length. It is gram-positive. Old cultures may assume thread-like forms. The organism is resistant to killing, as is shown in the following passage quoted from Hutyra and Marek:[1]

> The erysipelas bacilli manifest considerable resistance towards harmful influences, which they probably owe to a waxlike capsule (Schütz and Voges). Drying kills them only gradually as they remain alive when subjected to a temperature of 37°C. for 31, and to direct sunlight for 12 days (Sirena and Alessi). Heating to 70°C. destroys them in about 5 minutes. Pieces of meat not over 15 cm. thick require 2½ hours boiling for a complete sterilization (Stadie). Putrefaction does not destroy the bacilli in meat in 4 months (Stadie). Salting and pickling destroys them very slowly; pieces of meat and bacon may contain the virulent bacilli after lying in pickle for 170 days, and in a mixture of salt and saltpeter for 30 days, while in smoked ham virulent bacilli were found even after 3 months (Petri). On the other hand, continued smoking for 2 weeks or shorter periods of smoking once repeated destroys the virus of erysipelas in pieces of pickled meat not over 2½ Kg. in weight (Stadie).
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> Of the disinfectants the following are effective: Chlorate of lime (1%), hot lye (1%), soda (5%), iron sulphate (3%), copper sulphate (¼%), corrosive sublimate (.1%), carbolic acid, creolin and lysol (Petri).

[1] Hutyra, F., and Marek, J.: Special Pathology and Therapeutics of the Diseases of Domestic Animals. Translated by J. R. Mohler, A. Eichorn, P. Fischer, and H. J. Achard. Chicago, Alexander Eger, 1912, vol. 1, p. 62.

Infection in Swine as Prototype of Infection in Man

Swine erysipelas is a widespread infection among swine, more particularly on the European continent and especially in Germany, and it causes considerable financial loss. It is manifested in three forms: (1) a mild form, urticaria (diamond skin disease), characterized by slight constitutional symptoms and the presence of sharply circumscribed, rounded, quadrangular or rhomboidal spots on the skin, which are warm to the touch and dark red or violet in color; (2) a severe form, erysipelas septicemia and the presence of a diffuse erythema, areas of which may become gangrenous; (3) a chronic form, chronic erysipelas and endocarditis, occurring in animals that have recovered from the acute infection, and characterized particularly by polyarthritis and symptoms referable to what is a distinctive pathologic finding, *i.e.*, a vegetating type of endocarditis.

From information received and published in a previous report, it is evident that the infection exists among swine in the United States, in both the acute and the chronic forms. The acute form, however, is considerably less frequent. It is not definitely known just what the extent of the disease is in this country, but it is thought not to be very widespread. It is confined more or less to sporadic outbreaks, occurring in a limited

number of animals in different sections, and has never attained a serious epidemic form. In a previous study, however, we experienced no difficulty in obtaining from abattoirs sections of swine skin showing the lesions of the mild form of the disease, from which we isolated the organism for the purpose of studying its virulence.

Infection in Man

The symptomatology of infection with the bacillus of swine erysipelas depends on the virulence of the strain, which may be correlated with the source of the infection. As was stated previously, virulence can be modified experimentally. It appears also that modification occurs by passage of the organism through different media in its natural course of dissemination. In our studies, reported elsewhere, the mildness or severity of the infection in man could usually be correlated with the source of the infection and the virulence of the organism. The isolation of the organism and the study of its virulence are discussed later.

The acute septicemic forms of the disease (comparable to the same form in swine) are rare. German writers have reported cases, occurring for the most part in veterinarians accidentally inoculated through a prick of the needle when immunizing swine against the infection, with the serum of swine erysipelas and a small quantity of virulent culture. The patients presented the clinical picture of sepsis, with purplish-red lesions on various parts of the body; in some there were arthritic pains and evidence of endocarditis. Fatal cases have been reported. The literature contains no reference, however, to the occurrence of the acute septicemic form in this country.

The arthritic form of the disease, comparable to the chronic form occurring in swine, has been observed in man. Arthritic symptoms complicate the disease as it is usually manifested, or they may appear after cutaneous symptoms disappear or become much abated. We have observed only one case of this form.

The disease in this country is mild and can be compared to the mild form in swine—diamond skin disease. The clinical picture is that of a localized cutaneous infection, with mild or severe symptomatology. It commonly appears on the hands at the site of injury incident to a variety of causes, including the bite of animals, fish, or Crustacea. The incubation period ranges from one to four days, as compared with three days in swine. Infection can invariably be traced to contact with animals, fish, Crustacea, dead matter of plant and animal origin, or matter derived from animals, such as hides, pelts, bone, and manure. Erythema appears at the site of injury and slowly progresses, producing a sharply defined, slightly elevated zone, which extends peripherally as the central portion fades away with desquamation. A distinctive feature of the erythema is its purplish-red color, which is of considerable diagnostic import. This color is unique among skin diseases and is unlike the red that characterizes inflammation caused by other infections. The surface is smooth, and there are no papules or scales. The picture is not that of a cellulitis; there is no pitting on pressure and suppuration never occurs. The involved area is swollen and

tense. Subjective symptoms consist in itching, tingling, and more likely burning and throbbing.

Another distinctive feature of the disease is its migratory nature; new patches of erythema appear at remote areas. If the infection originally involved one finger, eventually all the fingers and the dorsum of the hand may become affected, the erythema appearing and disappearing; or extension may take place by continuity. Except in the severe forms, the disease rarely extends above the wrists. Relapses are common, and second attacks may occur. The milder forms may disappear spontaneously in from two to four weeks. We have seen exceptions, however, in which the disease continued for months.

In the severe forms, swelling is more pronounced, immobilizing the fingers, and hemorrhagic vesicles may appear at the site of inoculation. The subjective symptoms are so aggravated as to interfere with sleep. Sometimes mild constitutional symptoms occur, such as fever and lymphangitis, with enlargement and tenderness of the adjacent lymph nodes.

Industrial Incidence

Clinical and laboratory studies of the disease as it occurs among commercial fishermen working in fishpounds, published elsewhere in collaboration with Righter and Harkins (2), are here summarized.

The disease commonly appeared on the hands at the site of trauma usually incident to the bite of fish or to pricks from their scales, spines, or fins. The clinical picture was that of a severe form of infection, the symptomatology of which has already been discussed. We rightly suspected an infection due to a highly virulent strain of organism.

The bacillus of swine erysipelas was isolated from several of the patients by culturing a piece of skin and subcutaneous tissue removed from the site of infection. A forty-eight-hour pure culture in hormone broth killed pigeons in four days, following intramuscular injections of 0.001 and 0.0002 c.c., and killed white mice in from two to four days, following subcutaneous injections of amounts varying from 0.5 to 0.0001 c.c. A strain isolated from a mild form of the disease in a patient infected from skinning a rabbit was found to be much less virulent. A forty-eight-hour culture killed white mice in five days, following subcutaneous injections of 0.01 c.c. The animals survived injections of smaller amounts.

The handling of spiny fish, notable instances of which are the sea robin and the porgy, increased the incidence of the disease in commercial fishermen, as did also the handling of very slimy fish, such as sea bass and weakfish. The disease was most prevalent during the summer months, when the temperature of the water appeared to be a factor in determining its incidence. When the temperature of the water dropped from the usual 68° to 70°F. to about 62°F. or lower, there was a decrease in the incidence, even though slimy fish were caught. Perhaps this observation can be correlated with the fact that the bacillus of swine erysipelas grows best at a temperature of 68°F.

It was observed that fishermen came into close contact with many hundreds of live fish in removing them from the nets into the boats and again from the

boats into baskets. During this transfer, which is performed mostly by hand, the exposed parts of the body become saturated with fish slime. A uniform attitude among fishermen toward fish slime is that it is "poison," and they anticipate the appearance of the infection if it comes in contact with an abrasion or other epidermal defect. In all probability, the bacillus of swine erysipelas which we isolated from the involved skin of some of our patients is present on the skin of the hands and on the clothes of fishermen. An epidermal defect or trauma doubtless serves as a means of inoculation.

Consistent with this view is our observation that the infection occurred at the site of trauma inflicted through the soiled fishing clothes of the patient, and also at the site of friction between the skin and the soiled clothes: for example, on the skin of the arm beneath rolled-up sleeves; on the thigh beneath the top of the boot; around the lips, from wiping the mouth with the sleeve; and occasionally on the foot following a puncture wound through the boot.

Our findings also are in accord with those of others, previously cited, that the bacillus of swine erysipelas is resistant to killing. We observed the infection on the feet of a vacationist, at the site of a puncture wound from a fishbone incurred while walking barefoot along the dried sand. We also observed patients (vacationists) infected through handling dogfish, which apparently had lain on the beach for a long time and had dried thoroughly in the sun. In one patient the infection appeared at the site of a prick with the spine of a dried stuffed fish which was mounted. In another patient (a cook) it appeared at the site of a puncture wound with a spicule of crab shell which had been boiled previously in lye water.

We observed few cases of the infection among pleasure fishermen and among the large number of vacationists who go fishing and crabbing at the seashore. Among the latter, the infection could be traced in most instances to a prick of the sea robin, a spiny fish commonly used as bait. Such was the source of infection in two oystermen, who had never before been infected, in spite of the fact that they had on many occasions cut their hands while handling oysters. In these, as in similar cases among vacationists, no infection had resulted from the previous handling of menhaden or mossbunker, a nonspiny fish used as bait.

According to our observations the disease is the chief cause of disability among fishermen who work in fishpounds, and who handle live salt water fish. As far as we could determine, it is uncommon among commercial fishermen engaged in catching fresh water fish. This industry, however, in comparison with the salt water fish industry, is relatively small.

Our studies were confined to the northern Atlantic seacoast of New Jersey. For additional information we canvassed by letter many commercial fisheries that handle live fish and fish shipped to the market, also canners of fish and some physicians who treat the employees of such companies. The replies received from sources along the Atlantic coast, from Maine to Florida, justify the statement that the disease is widespread among commercial fishermen, and emphasize

the fact that it is an important disease of the fishing industry.

In the fishing industry, and indeed among some physicians, the disease is known simply as "fish poisoning." In some quarters we believe the infection is not recognized as erysipeloid, but is apparently regarded as a pyogenic infection incident to a puncture wound.

In our canvass, the rôle that slime and puncture wounds play in causing the infection was stressed, as well as the rather long period of disability. It was of interest to note in one reply: "Several typical instances of the infection resulted from scratching the hand on a dilapidated ice box formerly used for the storage of meat and fish"; and the following from a source concerned in the canning of fish: "It [the infection] occurs especially among the so-called bone pullers, that is, those who remove the small bones from the salt fish by means of pliers." From the same source the information was obtained that the infection occurred following puncture wounds with a fishbone in employees removing bones from haddock which had previously been steamed at a temperature of from 130° to 140° for a period of from fifteen to twenty minutes. The more probable source of the infection in these cases is the soiled hands of the worker, the trauma of the fishbone serving as a means of inoculation, rather than the previously steamed fishbone itself.

Dr. H. S. Davis of the United States Bureau of Fisheries informs us that an infection of fish with the bacillus of swine erysipelas is unknown. The organism is a saprophyte, particularly on the slime of fish, and refuse thrown into the water and other decaying matter are the sources of contamination. Apparently the change in environment increases virulence.

The infection appears to be not only less frequent among handlers of fish shipped to market, both wholesale and retail, but also milder, conforming to what is conventionally known as erysipeloid of Rosenbach. In this regard it is to be noted that before the fish are shipped, they are partly cleansed, washed in running water, and packed in ice. These measures remove slime and render the fish fairly clean and presumably less likely to cause infection. Moreover, the wholesale and retail handlers come into much less intimate contact with the fish than do the fishermen. Again, it is possible that the organism becomes less virulent.

Subsequent to the foregoing studies, we observed a patient with erysipeloid whose infection pursued a most unusual course, which furnished additional evidence of the severity of infection contracted from handling fish. The case history of this patient is as follows:

> The patient, four months prior to the time that we first saw him, pricked the index finger of the right hand on a tooth of a fish head used as bait in crabbing. Two days later the injured finger became considerably swollen, with a sensation of burning. A hemorrhagic vesicle formed which was incised, and a bloody serum was evacuated. The entire finger became involved, and the infection spread across the dorsum of the hand involving all the fingers and eventually the palm. Subjectively, the hand was achy, with a feeling of tightness and stiffness; the patient was unable to grasp objects firmly.
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> About five months from the onset the infection spread beyond the wrist and

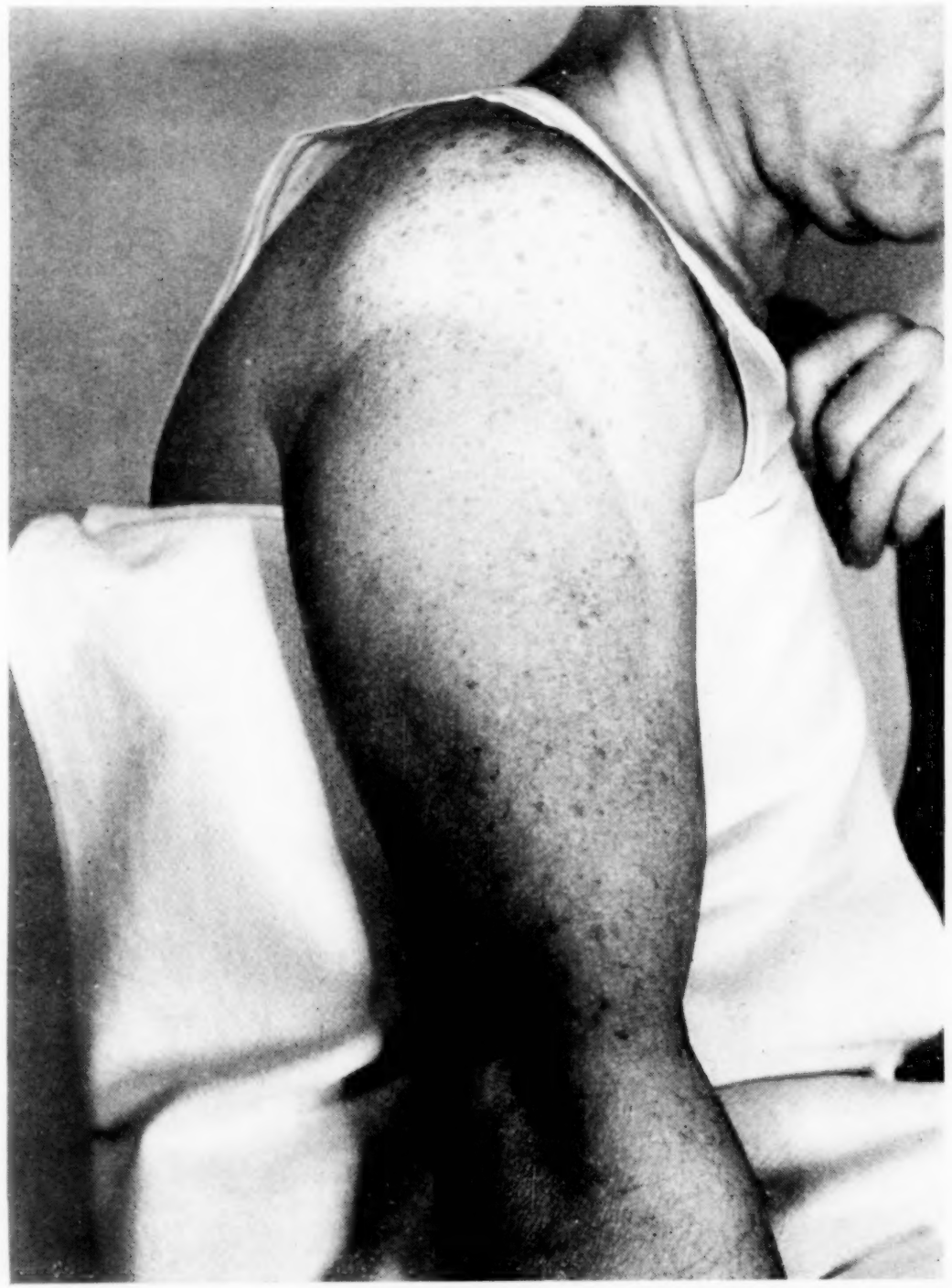

FIG. 1.—Showing erysipeloid on the arm as part of a generalized form of the disease. The entire cutaneous surface became involved in the course of a year from onset of infection on the finger, and the arthritic form of the disease developed. This photograph was taken about six months after onset of infection.

FIG. 2.—Same patient as in Figure 1, showing purplish-red, band-like areas of erysipeloid on the trunk. Marginated areas of erythema gradually progressed, involving the entire cutaneous surface. This photograph was taken about eight months after onset of infection.

gradually involved the skin of the forearm and arm. Arthritic symptoms developed, consisting in stiffness of the fingers and pain in the wrist and elbow, with restriction in the movement of the elbow. There was tenderness over the olecranon process. The infection gradually spread until at the end of a year it had extended over the entire cutaneous surface, from scalp to soles. At no time, however, was the entire skin surface involved; the extension was wave-like, with the advancing border always sharply marginated, appearing as a band of purplish-red erythema as shown in Figures 1 and 2. The skin posterior to the advancing border gradually became normal.

There were many cutaneous relapses, with purplish-red circinate areas of erythema appearing and disappearing at varying periods over the entire body. Such relapses were without subjective symptoms, but additional arthritic symptoms of varying severity appeared, consisting in stiffness, pain, dull ache, and slight puffiness involving the fingers and wrist of the left hand, the knee joints, and the ankles. Tender, firm, node-like lesions, which appeared and disappeared, developed near the knee and elbow joints.

X-ray examination of the joints, however, was negative; the involvement was apparently periarticular. There were no constitutional symptoms suggesting a blood stream infection. The bacillus of swine erysipelas was isolated from a piece of skin removed from an involved area on the forearm and was found to be highly virulent to white mice. About one year later the organism was again isolated from an involved area on the trunk.

A variety of local and internal treatments were without avail. Repeated injections of large amounts of immune serum promptly caused only temporary disappearance of the disease and did not prevent relapse. At the time of writing, eighteen months from onset of the disease, there is little change in the patient's condition.

The infection is apparently rare among veterinarians, particularly those inspecting swine in slaughter houses, and is relatively uncommon in the meat packing industry. This can doubtless be attributed to the lower incidence of the infection among swine in this country. Dr. W. H. Lipman, medical director of Swift and Company, Chicago, informed us that among about 6,000 employees handling swine flesh in the large abattoirs in Chicago, he would estimate that about twenty cases of the mild form of erysipeloid occur yearly. Dr. G. S. Gilpin of the same company in Cleveland estimates a higher incidence of at least twenty cases yearly among 1,000 employees. During the past year we have observed and treated eight cases of erysipeloid occurring among employees of the same abattoir in Philadelphia, employing 650 men.

A mild form of the disease exists among employees in the canning industry. Reference has already been made to inoculation of "bone pullers" engaged in the canning of fish, and we have been informed of the occurrence of infection among employees in a chicken canning establishment. From personal observation we cite a case in a woman who was engaged in filling glass jars and bottles with such food as India relish and potato salad, and who cut her finger on a broken bottle which had previously contained such food. The infection remained localized to the injured finger for five months; following local injection of immune serum it promptly disappeared.

Dr. George B. Lawson of Roanoke, Va., verbally informed us of an outbreak of erysipeloid, totaling 210 cases, among employees in a bone button factory in which the bones of cattle are utilized. This factory employs from 150 to 250 men. The infection appeared at the site of epidermal defect

incident to injury, and pursued a mild course. Second attacks of the disease were observed. A detailed report is being published by Dr. Lawson and Dr. M. S. Stinnett of Richmond, who isolated the bacillus of swine erysipelas from bone dust.

In addition to the sources of infection already cited, we have personally observed or been verbally informed of cases of infection apparently from the following unusual sources: from carrying an opossum with its tail wrapped around the fingers, which had been injured on a stone in a dried creek; from skinning a rabbit, and from other contacts with rabbits by rabbit breeders; from handling recently thawed fish in a zoological garden; from performing an autopsy on a dead animal in a zoological garden; from the sting of a jellyfish; and from the bite of a turtle.

Other industrial workers in whom the infection may occur are as follows: cooks; kitchen workers; shopkeepers handling meat, fish, cheese, game; tanners and handlers of hides and pelts; garbage collectors; workers in glue, tallow, fertilizer; pet animal shop employees; employees in pathologic, zoological, and biologic laboratories; farm hands and stablemen; taxidermists; employees in aquariums; handlers of poultry, game, and dairy products.

Erysipeloid should always be considered in infections arising at the site of injury in industrial workers engaged in occupations herein discussed. Although the acute septicemic form of the disease is apparently rare, nevertheless it should be considered in diagnosis of acute blood stream infections occurring in such workers.

Human infection in the United States is apparently much less widespread and less severe, except in fishermen handling live fish, than it is in Germany, according to the reports in the literature. From these reports it appears that infection in Germany is frequently due to contact with the flesh of swine. Among 233 cases reported by Bierbaum and Gottron, however, contact with fish was the most frequent source. These investigators mentioned the increase in the infection since 1920 and attributed it to a greater importation of American bacon and lard, which may have been contaminated in transit.

Considering the wide dissemination of the organism and its susceptibility to modification in virulence, it is not unreasonable to conclude that virulent strains of the organism may arise and that outbreaks of the disease may occur in certain industries. Consistent with this is the forementioned outbreak among employees in a button factory.

In prevention of infection the following considerations are pertinent: the habitat of the organism; the possibility of its presence on the hands of workers; the important rôle of injury or epidermal defect in causing infection; the resistance of the organism; and sanitary measures with reference to the presence of decaying matter.

Treatment

Many of the mild cases of erysipeloid run a self-limited course of about three weeks. In some patients, after a short period of apparent cure, the eruption reappears either at the same area or, more likely, at an adjacent, previously uninvolved area.

In this way the disease may continue for many weeks, and indeed months. The disease does not appear to be greatly helped nor its course shortened by local treatment with conventional applications, such as boric acid compresses, saturated solution of magnesium sulphate, tincture of iodine, or sulphonated bitumen.

Immobilization of the involved part and applications of heat are generally advocated as beneficial, and foreign protein therapy is recommended by some writers. Callomon favors wet dressing of alcohol and also application of sulphonated bitumen. Mühlpfordt reports favorable results from intensive and repeated use of ultraviolet ray. Fränkel highly recommends local application of a 3 per cent. alcoholic solution of trypaflavine followed by a dressing of sulphonated bitumen.

To quote the experience of others, according to information received in our canvass: "The condition seems to be more or less limited and responds but poorly to local treatment." "Patients lose two or three weeks in spite of all that one can do." "About the only effective treatment (one questions if it really shortens the course of the disease) is rest and heat in the form of wet packs."

Serum of swine erysipelas has long been used in Germany in immunizing swine against the infection, and it has also been employed in treating the disease in man. One disadvantage in its use, however, is the occurrence of serum sickness. Callomon points out that the incidence of this untoward reaction varies considerably with the different brands of serum available in Germany for human use. On account of its occurrence some German writers prefer not to use the serum in the mild and less complicated forms of the infection.

Serum of swine erysipelas has not been available in the United States. H. K. Mulford and Company prepared an immune serum from the strains of the organism isolated by us from the infection in fishermen, and this serum in doses of 0.2 c.c. protected white mice against a thousand times the fatal dose. Before injecting immune serum it is necessary to determine whether the patient is sensitized to horse serum. For this purpose the usual intracutaneous test is conducted. Depending upon the degree of sensitization, administration of serum may be contraindicated. At first we employed such serum in humans by injecting in the buttock a single dose of 25 c.c. Later we observed that smaller amounts injected subcutaneously by multiple punctures in and around the lesion were just as effective, if not more so. Administered in this manner, from 5 to 10 c.c., depending on the size and location of the lesion, may suffice to cause a rapid disappearance of the infection. In some patients, a second similar injection a few days later may be necessary.

Soon after the injection there is a local reaction consisting in swelling, and at times pain in the finger joints of the hand infected, with tenderness and enlargement of the lymph nodes draining the site of the disease, and urticarial lesions appearing near the site of the injection.

Criteria of the results obtained with serum therapy are enumerated in the caption of Figure 3. In this patient all symptoms of the disease disap-

peared within four days after injection. On the other hand, serum was ineffective in treatment of the patient with a generalized and arthritic form of infection, as already discussed.

Local injection of serum has been the most satisfactory treatment that we have employed. In contrast to the experience of German writers, serum sickness has not been severe enough nor its incidence sufficiently great to constitute an obstacle to its employment. Apparently, the toxicity of the serum employed is less than that of German brands.

Serum therapy has strikingly decreased the duration of the disease and the period of incapacitation, as compared with other forms of treatment. The following is a summary of the results of serum therapy in the eight cases of erysipeloid in abattoir workers previously cited: At the time of treatment, the duration of infection was from two to fourteen days. In three patients, local injections of serum were employed in amounts ranging from 6 c.c. to 10 c.c.; second injections were not necessary. In five patients, initial injections ranged from 4 c.c. to 16 c.c., and second injections two days later from 3 c.c. to 8 c.c. Six patients resumed work in from three to five days from the time of the first injection, and the other two in six and eight days, respectively.

Serum sickness did not occur in any of the patients. Local swelling was present in all patients, and in some it was accompanied by enlarge-

FIG. 3.—Erysipeloid of two days' duration in an employee in an abattoir who pricked his palm with a hog bone. A purplish-red erythema appeared two days later, with involvement of the hyperthenar eminence and part of the palm. A total of 10 c.c. of immune serum was infiltrated in and around the lesion. There was rapid disappearance of all symptoms; the area was normal the fourth day after injection. The only reaction was local swelling. There was no relapse.

ment and tenderness of the axillary lymph nodes. There was no relapse.

One disadvantage of local serum therapy is the pain incident to multiple insertions of the needle and the subsequent local reaction. This, however, is compensated for by the prompt disappearance of subjective symptoms of the disease which frequently include sleepless nights.

In one case, not included in this series, the infection existed four months, during which time the patient was incapacitated. Local injection of the serum caused a prompt disappearance of the disease.

Summary

Erysipeloid is an infection caused by the bacillus of swine erysipelas. The infection among industrial workers has received little attention as a disease of industry and is apparently insufficiently known to physicians engaged in industrial medicine. It occurs at the site of injury in workers in various industries coming in contact with living and dead matter of animal and plant origin.

The bacillus of swine erysipelas is widely disseminated; its habitat is dead matter of animal and plant origin. The organism is either pathogenic or saprophytic throughout the animal kingdom. In swine, which are more frequently infected than are other animals, it causes an infection known as swine erysipelas. The virulence of the organism varies in different animals and can be modified by passage through laboratory animals and also by culture. In its natural course of dissemination, virulence is apparently modified. The organism is resistant to killing.

The mild, severe, and chronic forms of the infection in swine are described and are compared with the forms occurring in man. In man, the mild form of the infection is most common, occurring at the site of injury, invariably on the hand, and appearing as a purplish-red erythema of a migratory character. Pain and swelling frequently cause incapacitation. The disease may spontaneously involute in from two to four weeks. In exceptional cases it extends above the wrists and persists for weeks, and sometimes months. Illustrations of the disease are presented.

The acute fatal form and the arthritic form of the disease in man are rare.

The infection is common among commercial fishermen working in fishpounds, handling live fish. It intimately concerns handling spiny fish as well as slimy fish. Spiny fish increase the incidence of trauma of the hands, which serves as a means of inoculation. In all probability the organism is a saprophyte on the slime of fish. The infection is an important disease of the fishing industry.

A case record of a patient infected from handling a fish is given. In this patient, the infection, originally confined to the finger, gradually spread over the entire cutaneous surface, and the arthritic form of the disease developed.

The disease also occurs among employees in the meat packing and canning industries, among food handlers, and among workers in industries where living or dead animal matter is handled.

Results of laboratory studies of the virulence of the organism obtained from

patients infected from different sources are presented.

Prevention of the infection among industrial workers and methods of treatment are discussed. Local treatment is of no great value. Immobilization of the part and application of heat are the methods generally advocated. The most satisfactory treatment, in our experience, however, is the local injection of immune serum. The technic of this treatment, the advantages and disadvantages of serum therapy, and the results obtained in a series of patients treated with serum injected locally are presented.

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SIR THOMAS MORISON LEGGE, C.B.E., M.D., D.P.H.

Sir Thomas Legge died on May 7 at Wintergreen, Warlingham, aged 69; and the science of Industrial Medicine lost an enthusiastic pioneer. THIS JOURNAL mourns its Honorary Consulting Editor, in which capacity Legge has acted since it was launched.

He was born at Hongkong where his father, James Legge, a Congregational missionary and Chinese scholar, was then stationed. Later he spent his boyhood in Oxford where his father had been appointed professor of Chinese in the University. This academic upbringing profoundly influenced his outlook on life. He was educated first at Dollar Academy, then at Magdalen College School and Trinity College, Oxford. He read physiology under Burdon Sanderson and Gotch, and after graduating with honors in science, passed to St. Bartholomew's Hospital to complete his medical course. Public health, rather than practice, attracted him; first he traveled on the Continent, and on his return, placed his experience on record in "Public Health in European Capitals," a useful description of sanitary administration. He was next appointed secretary to the Royal Commission on Tuberculosis which deliberated from 1896 to 1898. Thereafter he worked for a short time under Sir A. Newsholme who was then medical officer of health at Brighton.

But his life's work was really found when he became the first medical inspector of factories in 1898. At this time Sir A. Whitelegge, who had recently come to London from Yorkshire, was chief inspector of factories. Thus supervision of industrial hygiene for the first time was placed officially in expert hands. Legge entered upon the new work with enthusiasm and zest; soon he earned for himself recognition for his knowledge of occupational diseases and of the hazards from which they arose. At one time he directed his attention to industrial anthrax, upon which subject he gave his Milroy Lectures to the Royal College of Physicians of London. Then he concentrated upon lead poisoning and showed that this old time scourge of the potteries and other trades arose almost entirely from the inhalation of lead dust, instead of from absorption with food or through the skin, as was previously held. Preventive measures concentrated on removing the dust hazard have brought lead poisoning under control; and many codes of regulations based on this foundation have been established in all civilized countries. In the war time he quickly detected the poisonous nature of tetrachlorethane and of trinitrotoluene; he got the use of the former discontinued, and established hygienic control of the latter. Meantime light was being shed upon the origin and distribution of silicosis, and in this he played his part. In fact, a leading characteristic

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of his work was to show how important are the lungs as a portal of entry of noxious material, whether as fumes or as dust.

Legge hunted down the source of an industrial disease, so that it might be eradicated; and once it was found, he was relentless in the pursuit of preventive measures. Here he followed the light with something akin to religious fervor. This fervor finally determined him to retire rather earlier than he need, because he did not desire to administer the Lead Paint Act, which he felt could not abolish plumbism in painters; he advocated prohibiting the use of lead paints, which he held was an unnecessary trade custom. Even so, he did not cease work but joined the staff of the Trades Union Council in 1930 as expert adviser. Thus he was able to continue his help to the workingman for whom he had already done so much. In the Shaw Lectures before the Society of Arts in 1929 he told of his experiences during thirty years of official life; in a Chadwick Lecture he urged the need for every medical student to become acquainted with industrial hygiene.

Under the auspices of the International Labour Office he visited Geneva and also Washington. While in the United States he gave a series of lectures at Harvard and other universities; he also lectured at Montreal and Toronto. In 1918 he became a C. B. E., and in 1925 a knight.

As a man he was diffident, rather than assertive; yet once he was convinced of a line which should be pursued, he held on firmly with a bulldog tenacity. To his colleagues he was shy and almost brusque; but was always ready of his great knowledge to give freely facts and thoughts. His object was to advance his science; he cared little by whom the advance was made or to whom it was attributed. His joyful laughter comes back now to the writer when he detected how a famous colleague had unblushingly annexed as his own, research hidden away in a little-read foreign journal.

While his work was his pleasure, Legge had other interests; he was a fine skater and swimmer; he had a keen ear for good writing and rejoiced in Conrad and Arnold Bennett before their fame was recognized; but his favorite hobby was stained glass of the Middle Ages. He saw beauty where others saw only the sweat of toil; he saw grace in the activity of a foundry, and in work before the furnace; a factory girl appealed to his aesthetic sense rather than her sister on the stage. He loved the past for the light it shed on the present; and rejoiced in the present for its promise of the future. Now he has gone, and the world is the better for his life.—*E. L. Collis.*

BOOK REVIEWS

INTERNATIONALE ÜBERSICHT ÜBER GEWERBEKRANKHEITEN NACH DEN BERICHTEN DER GEWERBEAUFSICHTSBEHÖRDEN DER KULTURLÄNDER ÜBER DIE JAHRE 1927 BIS 1929. By *E. Brezina*, Sektionsrat im Bundesministerium für soziale Verwaltung; Professor an der Techn. Hochschule in Wien. Paper. Pp. 162 with index. Schrift. a. d. Gesamtgeb. d. Gewerbehyg., No. 36. Berlin: Julius Springer, 1931.

Every three years Brezina of Vienna issues a transcript of the cases of occupational disease which have been reported by physicians or factory inspectors to their respective governments during the preceding three years. He covers all countries that have well-established labor departments; namely, Great Britain, Germany, Austria, Holland, and Switzerland. The present volume deals with 1927, 1928, and 1929, and contains much interesting material.

Of the old familiar poisons, lead, of course, comes first. Teleky, who is in charge of the Düsseldorf district, says that it is a mistake to think that lead poisoning is rare at the present time and that severe forms of it are hardly ever seen any more. He finds that severe plumbism occurs quite frequently and even cases of encephalitis and of paralysis, not only the typical forms but some of unusual localization. He describes two cases of contracted kidney which he attributes to lead, one with optic atrophy, the other with apoplexy. There is also the case of a young woman engaged in glazing tiles, who had already suffered an attack of lead poisoning but was allowed to return to the same work and had another attack of colic, followed by encephalopathy with atrophy of the optic nerve and serious loss of power in the legs.

Adler of the Austrian factory inspection service states that she has seen recently several cases of typical lead poisoning in workers who had from one to several years been engaged in work free from lead. Sometimes the relapse followed almost immediately on the resumption of lead work, but in other cases it occurred without any further exposure.

Several unusual forms of lead poisoning are described. For instance, in Germany, a workman was awarded compensation for pulmonary tuberculosis which developed after chronic lead poisoning of many years' duration. Before the development, or, perhaps, rather the detection, of his tuberculosis his anemia had reached a high degree, the hemoglobin being only 56 per cent., and the stippled cells, which had been very numerous, disappeared entirely, showing that the regenerative power of the blood building organs was exhausted. Teleky, in the report for 1929, tells of a case of gastric ulcer in a zinc smelter who had a history of frequent attacks of typical lead colic; also a case in which the recrudescence of a gastric ulcer was attributed to an attack of severe lead colic. Adler found four cases out of eighty-seven in Austria to

be complicated with duodenal ulcer, and there is the description of a case in the Austrian report of a man who had a history of two attacks of colic but had been allowed to return to work in the corrosion chamber of a white lead factory. After nine days there, he sickened with intestinal cramps and bloody vomit, and died. The autopsy showed a ruptured gastric ulcer, the rupture being attributed to cramps induced by the lead.

In Germany the custom seems to have grown up among physicians of referring all cases of possible lead poisoning to the experts of the factory inspection service. We are told that in Breslau in 1929, 338 cases of suspected plumbism were examined and only thirty-three found positive and thirty-nine possible. In Saxony in 1927, 371 cases were reported, and in 145 the diagnosis was confirmed by the government physicians.

Outbreaks of industrial mercurialism have been surprisingly frequent in the German felt hat industry where before the war such cases were almost unknown. They are still rare in factories producing the better variety of hats, but the making of cheap felt hats has increased enormously and such felt requires the use of unusually strong carrotting mixtures, and the result is stomatitis and tremors among the workers. Thus in one plant no less than ten out of twenty-two women sizers showed tremors, and in another there were forty-four cases of mercurialism, all among women, some of whom had worked only six months. It is impossible to remove the fumes of mercury completely and the continual wearing of respirators in the hot steaming atmosphere cannot be enforced. A man 65 years of age, working for five months as a blower, suffered from stomatitis, greatly exaggerated reflexes, and pronounced tremors and disturbance of speech. There was a mercurial line on the gums and the blood showed a relative monocytosis.

Hydrogen arsenide is, as usual, shown to be responsible for a number of accidental deaths from the nascent hydrogen formed by the contact of zinc or iron with sulphuric acid. In a case reported from Germany, hydrogen arsenide was decided by the authorities to be the gas responsible for the death of a man who had dipped sludge from a tank car which had contained fuming sulphuric acid. Death followed fourteen days later, and the autopsy showed pneumonia of the right middle lobe, acute hemorrhagic inflammation of the kidneys, and fatty degeneration of the liver. In the great German chemical works the use of zinc coated dippers has been forbidden for some years, but in 1929 a man broke the rule and used a new dipper to clean from an autoclave sludge containing arsenic and dilute acid, thus producing the right conditions for the formation of hydrogen arsenide which caused his death.

A typical accident caused by nitrogen oxide fumes is reported from Germany. Three mixed acid tanks (H_2SO_4 and HNO_3) had to be cleaned from sludge, after being flushed with water seven times. The men who did the work were obliged to detach a crust of dry sludge with iron rods and in doing this liberated enough fumes to force them to work in shifts. None of them, however, felt any discomfort till that night, when all developed severe

dyspnea. The symptoms in two had vanished by morning, but the third died the following day although he was given inhalations of oxygen.

Teleky says that usually cases of carbon monoxide gassing recover promptly, but there are exceptions; for instance, he saw a case that was followed by weeks of profound mental disturbance. The patient could not even feed himself. Seven weeks later he still had amnesia and apraxia. He had almost forgotten how to read and could answer only the simplest questions about his immediate environment.

Many of the cases of gassing reported in recent years by German factory inspectors have occurred in garages or in drivers of trucks poisoned while making repairs. Thus there were four fatal cases and several severe, but not fatal, in garages in 1927; while in the two following years three truck drivers were fatally gassed. Among the unusual sources of carbon monoxide are the following: four cases with two deaths in cleaning the dust from a Cottrell precipitator; entering the concentration kettle of a sugar factory where carbon dioxide would be expected, but in this case carbon monoxide was demonstrated in the blood; a fatal case in the drying room of a brewery; a fatal case in an oxyacetylene welder, where the autopsy revealed inflammation of the lungs and "characteristic changes of subacute carbon monoxide poisoning in the brain." Tending lime kilns seems to be a prolific source of carbon monoxide gassing in Germany.

Two cases of poisoning by carbon dioxide, one of them fatal, occurred in a German sugar factory, the gas coming from the "lime furnace." Six others were in men cleaning out a receptacle in a factory making compressed yeast, the contents of the receptacle having undergone fermentation. In England there was a case arising from the gas generated in a brewery vat, and four cases from the vapors arising from a pit filled with powdered coal.

Benzene continues to take its toll among workmen who are obliged to enter tank cars or kettles for repairing or cleaning. Five such deaths were reported from England; Teleky reports three, two of them losing their lives in trying to rescue the first. As for chronic poisoning, no cases are reported from England but several from Germany. One severely poisoned workman, with 2,080,000 red cells, 1,800 white cells, hemoglobin 40 per cent., platelets 1,200, was saved by transfusion of blood and extirpation of the spleen.

Thirteen new cases of so-called aniline tumors of the bladder came to light in Germany during the three years, and twelve cases of hemorrhagic cystitis. The question whether such a tumor can be caused by anything except an amido compound arose in 1929 and is discussed by Teleky. A man died from carcinoma of the bladder after six years' work with trinitrotoluene. The claim for compensation was at first denied on the ground that such tumors had always been traced to amido compounds, but on appeal it was allowed on the theory that nitro compounds are in part reduced to amido in the body (trinitrotoluene is reduced to dinitro-hydroxylamino-toluene).

Trichlorethylene is coming into ex-

tensive use in this country and is being recommended as an ideal noninflammable, nonpoisonous, degreaser, and also as a thinner for nitrocellulose coatings. It is well, therefore, to note the fact that trouble has arisen from its use in Germany. During the three years in question cases of fairly serious poisoning, usually with loss of consciousness, have been reported from some fifteen different industries, and there were four deaths. Beintker says that loss of consciousness from trichlorethylene fumes is not followed by lasting effects, and Gerbis agrees to this in general but he has seen two men who suffered from paralysis of the sensory branches of the fifth cranial nerve which was still present eighteen months later. One of them also had ulcers on the cornea. He issues a warning with regard to the anesthetic effect of trichlorethylene on the cornea, which may lead indirectly to ulceration, as seen in some degreasers who did not realize the presence of foreign bodies in their eyes because of this loss of sensation. Two fatal cases were reported from accidental exposure to the fumes. Apparently the men fainted toward closing time and were not discovered; when the factory closed they were left unconscious in the poisoned air and they were found dead the next morning. (An almost identical accident occurred in a rubber factory in New Jersey a few years ago.) Another death was from aspiration pneumonia, the man vomiting before he recovered consciousness.

Late reports of the German factory inspection department add several very severe cases of methyl bromide poisoning, chiefly in the Wiesbaden district. Two of these were given in detail. The men were filling receptacles from a supply which was supposedly provided with an adequate exhaust system to carry off the fumes. Both were poisoned. One, who had already suffered one attack, died on the same day; the other survived but with such severe neuritic pains that he had to be sent to a sanitorium. This compound is used as a fire extinguisher in Germany and a workman filling extinguishers developed symptoms of poisoning sixteen hours after he had quit work, with muscular cramps, cyanosis, dyspnea, dilated pupils, loss of consciousness; and death followed in ten hours, with high fever. The autopsy showed edema of the brain and brown discoloration of the blood.

Ethylchlorhydrin was held responsible for two cases of gassing, with one death, which occurred in England in 1929. Middleton made the examination and decided that carbon monoxide was not the cause, but that it must have been an essential poison. There was some irritation of the respiratory tract but not enough to cause death. The autopsy findings pointed to a narcotic of the chloroform group, and the man was said to have fallen asleep in the doctor's waiting room.

There was a death from tetrachlorethane reported in England which was reminiscent of their war time experience, since it occurred in a 17-year old girl, and none of the other persons working in that room had suffered at all from the fumes. The girl was making frames for goggles with the use of celluloid dissolved in a 30 per cent. tetrachlorethane mixture. She suffered almost at once from nausea, then after four days had stomach distress enough to make her stay at home. She returned to work in the same room, and a couple of weeks later became jaun-

diced but she continued to work for fourteen days, becoming rapidly worse, with bleeding from the nose and the stomach. She died in ten days, after a total of forty-two working days. Atrophy of the liver was found. In Switzerland two young girls died with fatty degeneration of the liver. They had used this compound in a cement called "Resistin."

In Holland tetrachlorethane seems to be used as a fire extinguisher, and phosgene is formed from it under the same conditions as when carbon tetrachloride is used. Cases of phosgene poisoning reported in recent years in Germany have been caused by leaking cylinders in chemical works, and one, in a chemist, ended in death. The factory inspectors tell of an explosion out in the open which caused the death of two watchmen from fumes of phosgene; and there were also two cases, one fatal, from the phosgene produced from carbon tetrachloride used as a fire extinguisher. In England there were three cases of phosgene poisoning in 1927 and three in 1928, one of the last fatal, all in the chemical industry from leaking cylinders.

There were six cases of poisoning from nickel carbonyl in England in 1929, all acute and none with lasting effect. The men suffered from headache and sternal pain, inability to take a deep breath, dry cough, and pain and tenderness in the epigastric region. There was exudation into the finer bronchi but not into the lung tissue or the pleural cavity; and the classic symptom, deep inspiration and delayed expiration, was not seen. Two men had bad dreams and mental depression; two had fever.

Three workmen were suffocated in a tank full of nitrogen gas in Erfurt in 1928. Ozone, used as a laundry bleach, caused in some of the laundresses a pleasant feeling of exhilaration; in others headache and nausea. Morphine caused asthmatic attacks in drug factory employees, leading to sensitization so that quantities too small to weigh were enough to cause an attack; other workers had skin eruptions. In one plant 20 per cent. of the men and the women handling quinine were found to have skins sensitive to this drug.

Chloroform is apparently used in German industry as a solvent in cement for silk and satin hats and as a constituent of a rubber accelerator known as "Cosavult." Ether is also a constituent of cement. Drunken excitement or fainting or gastric pains are reported from their use.

Industrial thallium poisoning has attracted great attention in Germany since 1927. The first cases observed seemed to have been in a factory where potassium was recovered from refuse which contained small quantities of metallic thallium and also the oxide and sulphate. The engineer in control had during his preliminary experiments suffered from an attack of acute psychic excitement, and a 19-year old workman who assisted him suffered with severe pains in the legs. Four months later, the latter had atrophy of both optic nerves, and in one eye adhesions between the iris and the capsule of the lens, with cloudiness of the lens at this point. Vision was reduced to 2/60 on the right, and 2/36 on the left. There was loss of the patellar reflex on both sides and loss of the Achilles tendon reflex on one side. No improvement in his condition had occurred after nine months. Two other workmen had the same complaint

of pain in the legs and then, although they had quit work, a chronic nephritis with albuminuria developed, which had not disappeared after six months. Two others had reddish discoloration of the hair and loss of hair. Only three out of fourteen men exposed were unaffected; all the others complained of pains in the legs, and a sense of exhaustion; and all showed a lymphocyte count of over 40 per cent., with eosinophilia in some cases. There is no doubt that thallium was reponsible, according to Teleky. It is to be assumed that thallium is absorbed also through the skin. The case with atrophy of the optic nerve showed no improvement after two years.

Recent reports from the German factory inspection service tell of skin lesions and general disturbance of health from exposure to X-rays or radium on the part of technicians and their assistants, and also of industrial workers. Among the last was a man of 57 years, employed six years in the concentration of mesothorium preparations. In addition to severe typical lesions of the skin of the hands and forearms he complained of nervousness, headache, gastric disturbance, attacks of vomiting, cough, breathlessness on exertion, and also conjunctivitis with lacrimation. He had a low blood pressure and a small, rapid pulse. Blood examination showed hemoglobin 108 per cent., with moderate anisocytosis and eosinophilia. That same year there were two other similar cases. The following year a roentgenologist, who had failed to protect his neck and his legs below the knees, began to suffer from fatigue, loss of appetite, nervous irritability, followed by severe pains in the chest, and on one occasion complete collapse. He stopped work and recovered, except for twitching of the face muscles, but when he resumed work the symptoms recurred and he developed a leukopenia.

That there is still danger of phossy jaw in spite of modern factory sanitation is shown by a case of phosphorus necrosis of the right upper jaw, which occurred in Germany in 1928 in a man who had worked for fourteen years in the production of white phosphorus, sometimes at the furnace and sometimes at the retorts and autoclaves. There was also a case of jaundice and inflammation of the lungs in an Austrian workman exposed to phosphorus, which was probably to be attributed to the action of the phosphorus.

In 1927 there were cases of manganese poisoning in Hamburg, one of them leading to permanent disability; and six more were reported in that city the following year, these last being—according to the physicians—complicated with alcoholism. The following year Nuck reported four cases of manganese poisoning of the severest character in relatively young men, all of whom are completely invalided.

Not only skin diseases but inflammation of the air passages and rapid, difficult breathing, with fine, moist râles in the lungs, were reported by Gerbis, who examined a number of workmen exposed to fluorides in an electrochemical factory in 1929. A fatal case was caused by the sudden spurting of hydrofluoric acid from a flask, and severe burns in another factory from splashing of this acid. Several complaints of skin lesions and conjunctivitis, as well as one of bronchitis, from fluorides, were reported from Germany in 1927.—*Alice Hamilton.*